Remarks

Reconsideration and reexamination of the above-identified patent application, as amended, are respectfully requested. Claims 1-7 and 9-19 are pending in this application upon entry of this Amendment. In this Amendment, the Applicant has amended claim 1 and has added new claims 11-19. No claims have been cancelled. Of the pending claims, claims 1 and 11 are the only independent claims.

The Drawings

In the Office Action mailed on April 8, 2004, the Office Action Summary indicated that the drawings originally filed on October 3, 2003 have been objected to by the Examiner. However, the rest of the Office Action is void of any mention to the drawings including any mention of the drawing objections. Thus, the Applicant requests clarification to the drawing objections in the next correspondence from the Examiner. At that time, the Applicant will respond to any drawing objections.

Claim Rejections – 35 U.S.C. § 112

The Examiner rejected claim 8 under 35 U.S.C. § 112, 2nd paragraph, as being indefinite. The Applicant has cancelled claim 8 in order to facilitate allowance of the patent application.

Claim Rejections - 35 U.S.C. § 103

The Examiner rejected claims 1-4, 6, and 8-10 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,924,166 issued to Roussel ("Roussel") in view of U.S. Patent No. 4,583,190 issued to Salb ("Salb"). The Applicant believes that the claimed invention is patentable over any combination of Roussel and Salb and has amended independent claim 1 to more clearly define thereover.

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1.   The Claimed Invention

The claimed invention as recited in amended independent claim 1, is a method for determining the frequency of current ripples contained in the armature current signal of a commutated DC motor. The method includes determining a frequency spectral result of the armature current signal and determining a frequency spectral result of an electric operating parameter of the motor. The method further includes determining the frequency spectral result of the current ripples contained in the armature current signal based on differences between the frequency spectral result of the armature current signal and the frequency spectra result of the motor electric operating parameter. The current ripple frequency is then determined from the frequency spectral result of the current ripples contained in the armature current signal.

New independent claim 11 is generally similar to amended independent claim 1, but specifically recites that the frequency spectral result of the current ripples contained in the armature current signal is determined based on differences between the frequency spectral results of the armature current signal and the motor electric operating parameter without filtering any of the frequency spectral results of the armature current signal and the motor electric operating parameter. New claims 12-19, which depend from new independent claim 11, are identical to claims 2-7 and 9-10, which depend from amended independent claim 1.

2.   Roussel and Salb

Roussel generally discloses a circuit for shaping ripple in the armature current of a DC motor in order to eliminate interference superimposed on the armature current. To this end, Roussel discloses a circuit generally having a phase-locked loop circuit 100, a low-pass filter circuit 200, and a back EMF circuit 300. The low-pass filter circuit 200 and the back EMF circuit 300 receive a voltage Vshunt taken from the terminals of a shunt resistance connected in series with the motor armature. This voltage is directly proportional to the armature current.

The Examiner cited col. 5, lines 28-33 of Roussel for disclosing the step of subtracting the armature current signal and the motor electric operating parameter from one another to determine the current ripples contained in the armature current signal. The Applicant notes that an amplifier stage 320 of back EMF circuit 300 generates an output signal representative of the mean armature current. (See col. 5, lines 14-16.) A subtractor stage 210 of low-pass filter circuit 200 subtracts the mean component of the armature current from the voltage taken across the terminals of the shunt in order to output a signal representative of the periodic components of the armature current. (Col. 5, lines 28-33).

Low-pass filter 200 generally uses the output signal representative of the periodic components of the armature current to eventually provide a filtered input signal to a phase comparator 110 of phase-locked loop circuit 100. Back EMF circuit 300 generally uses the output signal representative of the mean armature current to eventually provide an input signal to a voltage controlled oscillator 130 of the phase-locked loop circuit 100. Phase-locked loop circuit 100 uses both of these two input signals to eventually produce an output signal which is the shaped armature current ripple as generated by the motor. The number of oscillations contained in the shaped armature current ripple are then counted. (Col. 2, lines 43-50.)

The Examiner noted that Roussel does not specifically determine a frequency spectral result of the determined current and voltage signals through digitization and a fast Fourier transform. The Examiner cited Salb for disclosing a system for converting signals from the time domain into the frequency domain using fast Fourier transforms. The Examiner posited that it would have been obvious to modify Roussel to include determining a frequency spectral result of the current and voltage signals, as taught by Salb, because this method for frequency analysis is well-known to provide a user with easier mathematical analysis and, as suggested by Salb, would have provided more accurate analysis due to the signals being better defined in classical mathematical signal processing terms (citing col. 7, lines 28-34 of Salb).

3. The Claimed Invention Compared to Roussel and Salb

The claimed invention generally differs from Roussel in that the claimed method includes determining the frequency spectral result of the current ripples contained in the armature current signal based on differences between the frequency spectral result of the armature current signal and the frequency spectra result of the motor electric operating parameter, and then determining current ripple frequency from the frequency spectral result of the current ripples contained in the armature current signal.

In contrast, Roussel is not concerned with the frequency of any of the signals. For example, Roussel counts the number of oscillations in the shaped armature current ripple signal in order to determine the position of a moving member (col. 1, lines 9-13; col. 2, lines 43-50). Generally, each counted number of oscillations corresponds to a position of the moving member. Roussel does not teach or suggest using the current ripple frequency of current ripples contained in an armature current signal to determine the position of the moving member. In contrast, Roussel teaches "counting the number of oscillations" in the shaped armature current ripple signal (col. 2, lines 43-40; claims 10 and 20).

Of more significance, Roussel does not teach or suggest, as the Examiner has noted, determining frequency spectral results of the armature current signal and the electric operating parameter. Nor does Roussel teach or suggest determining the frequency spectral result of the current ripples contained in the armature current signal based on differences between the determined frequency spectral results of the armature current signal and the electric operating parameter, and does not teach or suggest determining the current ripple frequency from the frequency spectral result of the current ripples contained in the armature current signal.

Roussel does not teach determining and/or using frequency spectral results as the disclosed circuit is intended to operate on inputted voltage signals in the time domain. Converting inputted voltage signals into the frequency domain does not seem to make sense

with the disclosed circuit of Roussel. For example, phase comparator 110 would appear to need signals in the time domain in order to function correctly. Likewise, the operational amplifiers and the transistors of low-pass filter circuit 200 and back EMF circuit 300 (see Fig. 8 of Roussel) would also appear to need signals in the time domain in order to function properly.

Accordingly, modifying Roussel with the teachings of Salb would result in making the disclosed circuit of Roussel inoperable. Further, the Examiner's motivation for modifying Roussel with Salb was that frequency analysis provides more accurate analysis due to the signals being better defined in the classical mathematical signal processing terms (citing col. 7, lines 28-34 of Salb). However, Salb notes that the disadvantage in using frequency analysis include "the much more intensive computation necessary as compared to time domain techniques." (See col. 7, lines 34-36 of Salb.). As such, it may not necessarily be evident to one skilled in the art to use frequency analysis instead of time analysis in those applications which could be properly used with either analysis.

Therefore, the Applicant believes that amended independent claim 1 is patentable under 35 U.S.C. § 103(a) over Roussel in view of Salb. Claims 2-4, 6, and 8-10 depend from amended independent claim 1 and include the limitations therein. Thus, the Applicant requests reconsideration and withdrawal of the rejection to claims 1-4, 6, and 8-10 under 35 U.S.C. § 103(a).

The Examiner rejected claim 5 under 35 U.S.C. § 103(a) as being unpatentable over Roussel in view of Salb and further in view of U.S. Patent No. 5,359,275 issued to Edwards ("Edwards"). Claim 5 depends on amended independent claim 1 and includes the limitations therein. As such, the Applicant respectfully requests reconsideration and withdrawal of the rejection to claim 5 under 35 U.S.C. § 103(a).

The Examiner rejected claim 7 under 35 U.S.C. § 103(a) as being unpatentable over Roussel in view of Salb and further in view of U.S. Patent No. 6,459,223 issued to Mauel

et al. ("Mauel"). Claim 7 depends on amended independent claim 1 and includes the limitations therein. As such, the Applicant respectfully requests reconsideration and withdrawal of the rejection to claim 7 under 35 U.S.C. § 103(a).

CONCLUSION

In summary, claims 1-7 and 9-10, as amended, and newly added claims 11-19 meet the substantive requirements for patentability. The case is in appropriate condition for allowance. Accordingly, such action is respectfully requested.

If a telephone or video conference would expedite allowance or resolve any further questions, such a conference is invited at the convenience of the Examiner.

Respectfully submitted,

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Date: April 13, 2004

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